The newsletter of
The Acoustical Society of America

ECHOES

Volume 12, Number 2
Spring 2002

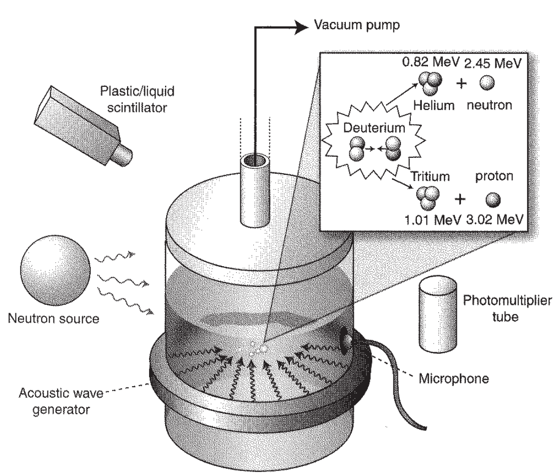
Sonofusion??

Thomas D. Rossing

Nuclear fusion, the source of energy in the sun, is potentially an attractive source of energy on Earth as well. The trouble is that only at exceedingly high temperature and pressure can atomic nuclei slam together hard enough to fuse and release energy. Hydrogen bombs achieve these conditions momentarily by setting off a small fission bomb, and fusion of small numbers of nuclei can be accomplished by the use of particle accelerators.

According to a report in the 8 March issue of *Science*, scientists at the Oak Ridge National Laboratory may have obtained nuclear fusion with the help of sound waves. Rusi Taleyarkhan and his colleagues used a beam of neutrons to produce bubbles into a small cylinder of acetone that had its hydrogen atoms replaced by deuterium (heavy hydrogen). Sound waves with a frequency of 19.3 kHz produced cavitation and resulted in flashes of light. But more interestingly, they also produced tritium (a still-heavier isotope of hydrogen) and neutrons, which the experimenters interpreted as evidence for fusion of the deuterium nuclei.

Subjecting a liquid to sound waves can produce a flash of light through a process called sonoluminescence (see *ECHOES*, Winter 1993, Summer 1997, Fall 1997, and Winter 1998, for example). Sonoluminescence occurs in a bubble that forms in the liquid, expands as the acoustic pressure decreases, then dramatically collapses, momentarily producing a very high temperature. The question is whether the temperature can be high enough to trigger nuclear fusion. Normally not, but in the very small bubbles created by the neutron beam, it may be possible, some scientists think.



Schematic of the experiment suggesting that deuterium nuclei undergo fusion inside sonoluminescent bubbles. [Illustration by Cameron Slayden reprinted with permission from Science 295, *8 March 2002, p. 1808].*

When two deuterium nuclei fuse, either of two reactions can take place. First, the two can form a nucleus of tritium, while the extra proton zooms off with an energy of 3.02 MeV (and would be quickly absorbed by the acetone). Second, the two deuterium nuclei can make a helium-3 nucleus, while the extra neutron flies off with 2.45 MeV. Taleyarkhan and his colleagues claim to have detected neutrons consistent with this energy, and they also claim to have observed extra tritium in the acetone solution. Both effects disappeared when they replaced the deuterated acetone with ordinary acetone, or made the temperature of the bath unfavorable for cavitation.

Too good to be true? The research paper submitted to *Science* apparently met with mixed reviews, but it finally passed the review process and was scheduled for publication. Several scientists urged that the paper not be published. Even science managers at Oak Ridge were having second thoughts, and they asked another team of nuclear physicists at the laboratory to conduct independent experiments with a different type of neutron detector. These scientists detected neutrons but at a level 10 times lower than they would have expected if deuterium fusion was taking place as reported.

Needless to say, the paper in *Science* attracted a lot of attention in the daily press. Unfortunately, perhaps, the articles in the press tended to focus more on controversy than on science. "Fusion Experiment Sparks an Academic Brawl" was the headline of a story in the Washington Post. Among the critics quoted in the story are William Moss (Lawrence Livermore Laboratory), Lawrence Crum (U.

continued on page 3

We hear that...

• **George Frisk**, Woods Hole Oceanographic Institution, is Chair of a committee of the National Academy of Sciences on Assessing Ambient Noise in the Ocean with Regard to Potential Impacts on Marine Mammals. Other ASA members on the committee include *David Bradley, Gerald D'Spain, Mardi Hastings, Darlene Ketten, James Miller, Daniel Nelson*, and *Arthur Popper*. This study was requested by the National Oceanographic Partnership Program with the Office of Naval Research, National Oceanic and Atmospheric Administration, the National Science Foundation, and the U.S. Geological Survey.

• **Jan Lindberg** received the IEEE-USA Electrotechnology Transfer Award. This award honors individuals whose contributions in key government or civilian roles led efforts to transfer advances in electrical, electronic, and computer technologies to the commercial sector.

• ASA members **John Eargle** and **Don Keele**, along with **Mark Engebretson** were honored by the Academy of Motion Picture Arts and Sciences with Scientific/Technical Awards honoring their roles in the development of cinema loudspeaker systems using constant-directivity horns and vented-box low frequency enclosures. ASA member **Tomlinson Holman** received an Academy Award for the research and systems integration resulting in the improvement of motion picture loudspeaker systems.

• **Christopher Struck** has joined the Licensing Division of Dolby Laboratories in San Francisco.

• **Thomas Rossing** presented an invited paper on "Light and Sound: Neglected Subjects in Physics Education" at a symposium on New Directions in Graduate Education at the March meeting of the American Physical Society in Indianapolis.

ECHOES

Newsletter of the Acoustical Society of America

Provided as a benefit of membership to ASA members

The Acoustical Society of America was organized in 1929 to increase and diffuse the knowledge of acoustics and to promote its practical applications.

Echoes Editor .Thomas Rossing

ASA Editor-in-Chief . . . . .Allan Pierce

Assistants . . . . .Elaine Moran, Charles Schmid

Phone inquiries: 516-576-2360. Contributions should be sent to Thomas Rossing, Physics Dept., Northern Illinois University, Dekalb, IL 60115<Rossing@physics.niu.edu>

NOISE-CON Proceedings on CD-ROM

INCE/USA announces that a CD-ROM containing the proceedings of NOISE-CON for 1996, 1997, 1998, 2000, and 2001 is available from Bookmasters, Inc., Distributions Services Division, 30 Amberwood Pkwy, Ashland, OH 44805 (Telephone: 800-247-6553, email: order@bookmaster.com). Priced at $70, the CD-ROM also includes the proceedings of the 1998 Sound Quality Symposium, and a sample of audio signals for analysis or demonstration.

Acoustical Society Foundation – A Family Affair

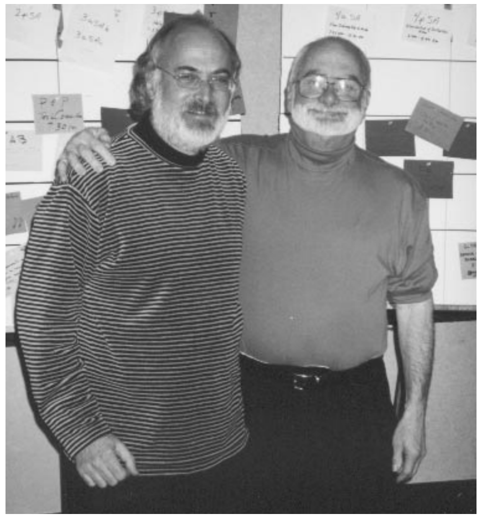
Bob Frisina

Foundations can be a focal point for honoring and remembering our family members. For the former, a wonderful event took place at our recent Ft. Lauderdale Acoustical Society meeting. On Wednesday of that week, the Foundation and the College of Fellows carried out some exciting events for ASA and the Junger family. A special session organized by Ira Dyer celebrated the noteworthy professional accomplishments of Miguel Junger, a long-time prominent member of ASA. That evening, at a special dinner, Miguel introduced our guest speaker: Miguel's son Sebastian, a well-known foreign correspondent for national radio and television newscasts and magazines, author of *The Perfect Storm*, and his newly-released book *Fire*. Sebastian's presentation focused on recent events in Afghanistan that he personally covered while stationed on the front lines of the Northern Alliance in October and November of 2001. Sebastian was delayed in coming back from the front lines during Thanksgiving week, which resulted in much concern for his parents, as well as for those of us organizing the Junger dinner! Sebastian also reported on the help he received from his father, in writing key portions of *The Perfect Storm*, concerning ocean waves and weather patterns. I can relate to the joy conveyed by Sebastian in working with his father. My own father has been a long-time non-profit fund-raiser, and has helped me in carrying out Foundation initiatives. The Foundation is currently working on more special fund-raising events in conjunction with the Society's upcoming 75th Anniversary in 2004. Contact Bob Frisina with any ideas or initiatives you may have in mind for these, at 585-275-8130 or asf@q.ent.rochester.edu.

ASA returns to Pittsburgh after 68 years

The 143rd meeting of the Acoustical Society of America will be held in Pittsburgh as was the 12th meeting in 1934. If absence makes the heart grow fonder, this meeting should be a very special one. Pittsburgh, located at the juncture of three important rivers, is a very interesting city to visit.

The 143rd meeting, with 715 technical papers arranged into 72 sessions, includes something for everyone. Two special lectures on the history of acoustics are "History of Signal Processing in Acoustics" presented by David I. Havelock on Tuesday, 4 June, at 11:00 a.m. and "History of Structural Acoustics and Vibration," presented by David Feit, Murray Strasberg and Eric E. Ungar on Wednesday, 5 June, at 10:55 a.m. On Wednesday afternoon, 5 June, a Hot Topics session will highlight current topics in the fields of Signal Processing in Acoustics, Psychological and Physiological Acoustics, and Engineering Acoustics.



Richard M. Stern, Pittsburgh meeting Technical Program Chair, and Richard Stern, ASA President-Elect, at the TPOM

A tutorial lecture titled "Keep Your Ear on the Ball: Display of Targets in the Bat's Sonar Receiver," will be presented by James A. Simmons of Brown University on Monday, 3 June, at 7:00 p.m. At the plenary session on Wednesday afternoon, Gold Medals will be presented to Robert Apfel and Tony Embleton, the Silver Medal in Psychological and Physiological Acoustics will be presented to Neal F. Viemeister and the R. Bruce Lindsay Award will be presented to James Finneran and Thomas Royston. The Medwin Prize in Acoustical Oceanography will be presented to Bruce Cornuelle.

A short course on conversational systems will be held Saturday, 2 June, 1:00 p.m. to 5:00 p.m. and Monday, 3 June, 8:00 a.m. to 1:00 p.m. at Carnegie Mellon University. Bus transportation between the Pittsburgh Hilton and Carnegie Mellon University will be provided.

There are three technical tours: 1) Heinz Hall and Benedum Center, 2) Heinz Stadium and PNC Park, and 3) MSHA and NIOSH. You must register in advance so that tours and bus transportation can be arranged. The music halls and the stadiums are within walking distance of the Hilton, while the MSHA/NOISH tour will require bus transportation.

No ASA meeting is all work and no play. A complimentary buffet social with cash bar will be held from 6:00 p.m. to 7:30 p.m. on Tuesday evening in the Grand Ballroom 1 at the Pittsburgh Hilton. Thursday night's social will be held on a river boat. The river boat will be available for boarding at 5:30 p.m. with departure at 6:00 p.m. from the Point State Park located directly in front of the Hilton (there will be a short walk from the Hilton to the boat). The cruise of the three rivers (Allegheny, Monongahela and Ohio) will provide an excellent view of Pittsburgh and surroundings, such as Mt. Washington. The boat will return to Point State Park at 7:30 p.m. in time for you to return to the Hilton to attend the Technical Committee meetings.

The Three Rivers Art Festival, located adjacent to the Hilton, will coincide with the ASA meeting. Museums include the Carnegie Science Center, the Carnegie Museum of Art, The Frick Art and Historical Center, the Carnegie Museum of Natural History, and the Andy Warhol Museum.

(Sonofusion??, continued from page 1)

Washington), and Seth Putterman (UCLA), all familiar names to readers of JASA and ECHOES. "I reviewed the paper twice, I rejected it twice," Moss is quoted as saying. On the other hand, Russ George, a scientist who has worked on alternative energies, defends the paper, pointing out that the critics "are not happy that they are beaten to the prize." Don Steiner (U. Rochester) is quoted as saying that he believes "there is a 50-50 chance that fusion events did occur."

The critics aren't saying that fusion could not have occurred, only that its occurrence hasn't been proven. Putterman and his colleagues suggested the possibility in 1994 when they calculated the shock wave that might develop within a collapsing bubble containing deuterium (*Phys. Rev. Lett.* 72, 1380 (1994)). Moss made a numerical simulation that showed it might be possible to obtain high enough temperature and pressure in a bubble containing deuterium (*Phys. Lett.* A211, 69 (1996)).

Undoubtedly, the experiment will be repeated elsewhere. Sonoluminescence researchers Kenneth Suslick (U. Illinois) and Putterman reportedly have plans for a similar experiment using laser light rather than neutrons to produce the tiny bubbles, thus assuring that any neutrons detected are not produced by the neutron generator. Lee Riedinger, deputy director for Science and Technology at Oak Ridge estimates that 20 to 30 laboratories in the U.S. could replicate the experiment, and hopes that scientists will give the public a verdict within six months.

At any rate, the experiments have brought acoustics into the news!

The Early History of High Frequency, Short Range, High Resolution, Active Sonar

Chester M. McKinney

It would be difficult to overestimate the importance of Sonar (SOund NAvigation and Ranging) in the exploration of the ocean, in the study of marine life, or in military operations and the defense of our country. The purpose of most sonar systems is to detect and localize a particular target, such as submarines, mines, fish, or surface ships. Other sonars are designed to measure some particular quantity, such as the ocean depth or speed of ocean currents or to image remote objects. Long-range detection sonars generally operate at frequencies below 50 kHz, while mine detection sonars operate at frequencies above 50 kHz.

This note is a brief history of the development of a broad class of active sonars that generally have most or all of these characteristics: relatively high operating frequencies (35 to 1500 kHz); short range (a few meters to 1.0 km); high range resolution (1.0 m to a few cm); and high cross range resolution (a few degrees to 0.1º). Although there are a host of applications for such sonars, I have chosen to consider only on those developed by a number of navies to detect, classify, and even identify small objects such as naval seamines. These seamines typically have dimensions of 1 or 2 meters, weights of 1.0 ton or less, and may be moored in the ocean volume, rest on the bottom, or even be buried in the bottom sediment.

The father of minehunting sonar was the famous French scientist, Paul Langevin, who in 1916-18 was able to detect a mine at a range of 100 meters, using his active echo ranging sonar, operating at a frequency of about 45 kHz. The mine probably was a spherical moored type, about 0.75 cm in diameter. The important point is that as early as World War I some navies were interested in finding mines by sonar.

During the period between WWI and WWII, the British were more active in the development of mine hunting sonar than were other navies. In general, most of these were antisubmarine warfare (ASW) sonars that were modified to operate with a shorter pulse, although some also operated at a slightly higher frequency. Beginning with the German use of influence mines in 1939, the emphasis was on being able to detect mines resting on the ocean floor. In brief, the British concluded that none of these sonars was adequate for the task.

It is interesting to trace the threads of development of three types of sonar that are historically important: pulse-type ahead searching sonars, continuous transmission frequency modulation (CTFM) sonar, and very high resolution side scan sonar.

Pulse-Type Ahead Searching Sonars

The first major U.S. effort to develop a minehunting sonar was the Underwater Object Locator (UOL) program at General Electric Co., initiated in 1942. The idea was to use a narrow beam (~1.5º), operating with continuous transmission at 1.0 MHz to mechanically scan a field in elevation and azimuth to paint an acoustic picture of the target (an acoustic camera). The program moved from the UOL MK-1 thru the UOL MK-IV, with a steady reduction in frequency (1.0 MHz to 100 kHz). In 1951, in reaction to the disastrous encounter with mines in Korea, the U.S. Navy greatly expanded its effort in mine countermeasures and procured the AN/UQS-1 in quantity (160).

The AN/UQS-1, a 100 kHz sonar with 1.0 ms pulse, and 2.0º horizontal resolution, was subjected to extensive operational evaluation in the early fifties. It was determined that it could detect conventional bottom mines at ranges up to a few hundred yards, but it suffered from a critical weakness. In most shallow water areas with high traffic the ocean floor is cluttered with lots of junk, many pieces of which are comparable in size and target strength to mines. To investigate every target detected reduced the search and clearance rate to unacceptable low levels.

The inability of the AN/UQS-1 and other sonars developed before about 1950 to discriminate between mines and other targets at acceptable ranges led several navies to develop sonars that could classify targets detected as being mine-like or non-mine-like. While there are several target classification clues, by far, the most successful approaches were to image the size and shape of the target and its acoustic shadow which required better range and cross-range resolution. It was straightforward to obtain higher range resolution by using shorter pulses (~0.1 ms), but better cross-range resolution was more difficult to achieve. Higher frequencies were employed, but at the cost of shorter ranges. In brief, several successful sonars were developed that did provide crude but useful images with the range resolution being much better than the cross-range resolution.

In the post WWII period, the British conducted an excellent basic research program on minehunting sonar that resulted in the development (ca. 1960) of the Type 193, a two-frequency sonar (100 and 300 kHz) with a 100 microsecond pulse and horizontal beamwidths of 1.0 and 0.3º, which was the first successful operational mine detection-classification sonar: On a slightly later time schedule (ca. 1965), the U.S. Navy (USN) developed the AN/SQQ-14 mine detection-classification sonar with parameters similar to those of the Type 193. This was the primary USN surface ship minehunting sonar until the early nineties, and is still in service in several navies. By 1970 the French also had developed a two-frequency system (Type DUBM 20-21) that was similar to the Type 193 and SQQ14. These sonars were used on most of the ships (from eight countries) that detected and destroyed almost all of the 1200 mines planted by Iraq in the 1991 Persian Gulf War.

Continuous Transmission Frequency Modulations (CTFM) Sonar

When the U.S. entered WWII its ASW active sonar was the single beam Ping-Train-Listen type, which provided a very slow search rate, and the need to increase the information rate was evident. In due course, the Harvard Underwater Sound Laboratory (HUSL) developed the capacitive scanner system, which the USN selected to be its primary active ASW sonar. In the same time period, the University of California Division of War Research (UCDWR), in San Diego, developed the QLA, a continuous transmission frequency modulation sonar (CTFM) that operated in the frequency band 36 – 48 kHz. In this sonar, the continuous transmitted signal was periodically and linearly swept from 48 kHz to 36 kHz. The received echo from a target, delayed in time, was mixed with the transmitted signal, resulting in a difference frequency proportional to target range, in the audio band. This audio signal was presented to the operator via earphones and, after spectrum analysis, to a visual display.

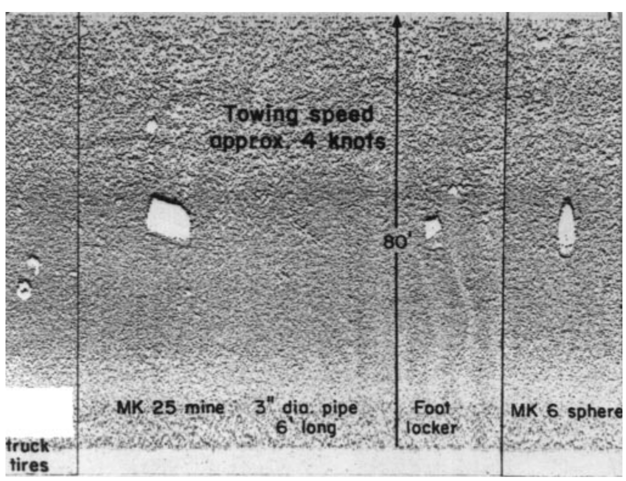
In 1944, Admiral Lockwood, Commander of SubPac, was looking for means that would help his submarines penetrate Japanese fields of moored contact mines, and 21 QLA sonars were installed topside on his subs. These sonars proved to be very effective in detecting and avoiding the mines and the QLA achieved an excellent reputation for itself and CTFM sonar in general. Operators liked the combination of visual and aural displays. This probably was the first time that sonar had been used to penetrate a live minefield in wartime and it can be argued that it was the most important to date. In hindsight, it is amazing that the QLA performed so well when one considers that it was by no means a high resolution sonar. The resolution cell of 20 yds x 12º certainly was larger than the mines. I believe that the excellent performance was due primarily to the relatively wide bandwidth (12 kHz), which combined with the bandpass filter in the receiver probably resulted in a suppression of the reverberation of about 20 dB. Regardless of the explanation, the QLA must be considered an historically important sonar.

Very High Resolution Side Scan Sonar

Another development thread that is very important not only historically but also for current broad applications, is the very high resolution side scan sonar, proposed by the USN Mine Defense Laboratory and developed by Westinghouse. The basic concept was to be a 1.5 MHz single beam system that would be towed through the water with the sonar beam looking to the side. The forward motion of the towed body would produce the second dimension for a plot of the searched area. The first images obtained with this sonar (known as the Shadowgraph) in the summer of 1957 were beautiful and dramatic in terms of the details of the shadows of bottom targets (see photo). The range and cross-range resolution were about 1.5 and 3 inches, respectively. A very important design feature was that the projector and receiver, each about 24 inches long, were curved with a radius of 15 ft, so that the beams were in focus along a line that passed through the center and normal to the plane of curvature. By towing the transducer array 15 ft above the bottom, the beams were in focus along the bottom, a very important design feature. Of course, the good images were obtained at the expense of having a very short maximum range, namely about 80 feet. This sonar demonstrated:

(1) the value of very high resolution; (2) the value of the acoustic shadow for target classification; (3) the value of focusing; (4) the capability of having a high probability of target detection and classification simultaneously with a single beam sonar; and (5) the concept and value of high resolution side scan sonar for mapping the floor of the ocean. Good use was made (required) of bottom reverberation for effective operation.

The operational version of this sonar, the C-MK-1, was evaluated by the Navy and approved for reconnaissance and surveillance. The French Navy built their DUBM-41, under license from Westinghouse, that was very similar to the C-MK-1, except it operated at about half the frequency in order to increase the range. The French Navy used this system for at least 25 years for conducting bottom surveys. At about the same time, the USN developed the AN/AQS-14 for use with its mine countermeasures helicopters. This system operated at a lower frequency than the C-MK-1 in order to achieve longer ranges. A major contribution of the AQS-14 is the use of multiple parallel receive beams, which allows a much higher speed-of-advance by the helicopter without leaving holidays. It also employs dynamic focusing. This sonar is currently in use by the Navy and was very effective in finding Iraq mines in the Persian Gulf in 1991.



Display of early side scan sonar, CMK-1 Shadowgraph, ca 1957. Targets are on a sand ocean bottom. Photo courtesy of Art Nelkin.

History Omitted

This note has discussed primarily the development of complete sonars. In parallel, the high frequency, high resolution community was conducting considerable

continued on page 7

Scanning the Journals

Thomas D. Rossing

• "Hearing tests, environmental measurements and acoustic phenomena may together explain why boats and animals collide" is the subtitle of an article on **"Manatees, Bioacoustics and Boats"** in the March-April issue of *American Scientist*. After more than two decades of manatee-protection policies that have focused on slowing boats passing through manatee habitats, the number of injuries and deaths associated with collisions has increased, the authors point out. Researchers at the Charles E. Schmidt (not ASA's Charles E. Schmid) College of Science at Florida State University have determined that manatees have a functional hearing range from 400 to 46,000 Hz, with a peak sensitivity between 16 and 18 kHz. Thus they are unable to hear the dominant low frequency sounds of most boats, and they may be least able to hear the propellers of boats that have slowed down in compliance with boat speed regulations intended to reduce collisions. Furthermore, the Lloyd mirror effect can attenuate or cancel the propagation of low frequency sounds generated near the surface, where the risk of collisions with ships and boats is greatest.

• **Auditory spatial perception** is strongly influenced by visual clues. A paper in the 14 March issue of *Nature* shows that an auditory aftereffect occurs from adaptation to visual motion in depth. After a few minutes of viewing a square moving in depth, a steady sound was perceived as changing loudness in the opposite direction. Adaptation to a combination of auditory and visual stimuli changing in a compatible direction increased the aftereffect and the effect of visual adaptation almost disappeared when the directions were opposite. For processing of motion in depth, the auditory system responds to both auditory changing intensity and visual motion in depth.

• **"Sending Sound to the Brain"** is the title of an article in the 8 February issue of *Science*. The review article on cochlear and auditory brainstem implants is part of a special section on "Bodybuilding: The Bionic Human." Early cochlear implants were designed primarily to replace the lost function of the cochlea with little regard for the way the brain processes and adapts to auditory information. Deaf patients without an intact auditory nerve may be helped by the next generation of auditory prostheses: surface or penetrating auditory brainstem implants that bypass the auditory nerve and directly stimulate auditory processing centers in the brainstem. Existing auditory brainstem implant (ABI) technology (implanted in about 200 patients thus far) stimulates the surface of the ventral cochlear nucleus in the auditory brainstem, the next stage of auditory processing after the cochlea.

• A simple **photoacoustic detector**, suitable for use in student laboratories, is described in the October issue of *The Physics Teacher*. The converter cell consists of a half-blackened pickle jar driven by the fluctuating light output of a conventional ac-powered incandescent bulb. Light is absorbed by the blackened surface and the energy is dissipated as heat. The surrounding gas heats and cools in synchrony with the periodically varying light flux, and under favorable conditions the resulting pressure variations can be detected by the ear at twice the line frequency. Essentially, the pickle-jar converter acts as a Helmholtz resonator.

• Pulses of energy called **planetary waves** traverse the globe, protecting the Arctic ozone layer and influencing weather and climate, according to an article in the 24 January issue of *Nature*. At their largest scale, they straddle the Earth. Without them, ozone depletion in the stratosphere would be worse and more frequent than it is now. The Southern Hemisphere provides a taste of what could happen to the Arctic ozone layer if the influence of the Northern Hemisphere's planetary waves weakens, which the build-up of greenhouse gases in the atmosphere could cause.

• The midbrain contains an **auditory map** of space that is shaped by visual experience, according to a letter in the 3 January issue of *Nature*. When barn owls are raised wearing spectacles that horizontally displace the visual field, for example, the auditory space map in the external nucleus of the inferior colliculus shifts according to the optical displacement of the prisms.The authors report on studies of the effect of a restricted, unilateral lesion in the portion of the optic tectum that represents frontal space. Such a lesion eliminates adaptive adjustments in the auditory map that represents frontal space on the same side of the brain. Topographic visual activity in the optic tectum could serve as the template that instructs the auditory space map.

• A physics teacher in Spain has calculated speeds of sound and conversational sound levels in the atmospheres of **7 planets** with atmospheres, plus the Jovian satellite Titan and the extrasolar planet HD209458B, and published them in a paper in the April issue of *The Physics Teacher*. Excluding HD209458B (which is very hot), Jupiter has the highest speed of sound (1200 m/s).

• Ingenious **software** developed by the British company Sensaura makes ordinary loudspeakers "come alive," according to a note in the February issue of *Scientific American.* The program enables ordinary computer speakers, television sets and headphones to create the illusion that sounds are coming from anywhere around a listener's head. Last November the Royal Academy of Engineering recognized the accomplishment by awarding the MacRobert Award to Sensura. So far the most popular application has been in enhancing the sounds of computer games, but the same technology can also enrich the music from CDs and MP3 files.

• Although it is not clear whether humans are able to **learn while they are sleeping**, evidence is shown in a paper in the 7 February issue of *Nature* that human newborns can be taught to discriminate between similar vowel sounds when they are fast asleep. Mismatch negativity (MMN) was used to determine the ability of newborns to detect a change in speech sounds. MMN can be observed in young infants throughout all sleep stages as well as when they are awake.

• Physicists have been contributing in an increasingly significant way to **modeling the brain** and designing effective substitutes for sensory inputs to the brain, including cochlear implants, according to an article in the February issue of *Physics World*. Interacting more closely with the brain than any other prosthetic device, cochlear implants are an incredible medical and bioengineering achievement. They convert external acoustic information into electrical stimuli and then present this information directly to the auditory nerve via electrodes inside the cochlea. To describe mathematically how this information is handled by the brain is an extremely difficult task that has only been seriously tackled in recent years. There appears to be some link between the underlying nature of quantum mechanics and aspects of brain behavior.

• The November/December issue of *Acustica* is a special issue on **tomography and acoustics**. The papers deal with tomography and its applications especially to the atmosphere and the oceans. The papers resulted from a workshop at the University of Leipzig March 6-7, 2001.

• The effect of the duration of head-related impulse responses (HRIRs) on the **localization of virtual sound** is discussed in a paper in the January/February issue of *Journal of the Audio Engineering Society*. The accuracy with which three subjects could localize virtual and free-field sound was measured using an absolute localization paradigm incorporating 354 possible sound-source locations. Localization performance gradually decreased as the HRIR duration was reduced, and first became significantly worse than that for free-field sound at HRIR durations ranging from 0.32 to 5.12 ms. Localization performance for virtual sound was not disrupted dramatically until the HRIR duration was reduced to 0.64 ms.

• A multi-year project at the IBM Research Laboratory in Yorktown Heights, NY aims to develop a **speech recognition system** that will understand 20 languages and operate with 98 percent accuracy, according to a note in the May issue of *Technology Review*. IBM hopes the system will improve on present day systems by including new algorithms that consider the context of the conversation.

• **Chimaeric sounds** have been used to investigate the relative perceptual importance of the envelope and the fine structure of a sound, according to a paper in the 7 March issue of *Nature*. Chimaeric sounds have the envelope of one sound and the fine structure of another, not unlike hybrid sounds in electronic music that combine features from different sounds. The envelope is found to be the most important for speech reception, while the fine structure is most important for pitch perception and sound localization. When the two features are in conflict, the sound of speech is heard at a location determined by the fine structure, but the words are identified according to the envelope. Speech chimaeras were created by combining either a speech sentence and noise or by combining two separate speech sentences.

• Brain imaging techniques, such as positron emission tomography (PET) and functional magnetic resonance imaging, and methods that measure active of neurons in the cerebral cortex, such as electroencephalography and magnetoencephalography (MEG), have been used to study the relationship between **melody, harmony and rhythm in music**, according to a note in the 7 March issue of *Nature*. By studying activity in the auditory cortex in response to music, scientists have concluded that the secondary cortex mainly focuses on harmonic, melodic and rhythmic patterns, and the tertiary auditory cortex is thought to integrate these patterns into an overall perception of the music.

(History of Sonar, continued from page 5)

research on transducers, electronics, target echo structure, and environmental features, all of which was necessary in order to provide a firm base for good engineering design. To keep this short, we have omitted discussion of this very interesting and important area of work as well as any coverage of several relevant topics such as high performance sonars for use on manned and unmanned submersibles and acoustic camera type of sonars. It should be obvious that we have completely left out any discussion of some of the very best high resolution sonars, namely those of the dolphin. But that is really ancient history (and pre-history).

Chester McKinney, a retired researcher at the University of Texas Applied Research Laboratories and a past ASA president, has been involved in R&D on mine hunting sonar for the past 50 years. This article is adapted from his paper at the 142nd ASA meeting at a special session on the history of sonar.

Acoustics in the News

- Concatenative synthesis of speech, developed by Juergen Schroeter and his colleagues at AT&T Labs, offers realism for "voices" of computers, automobiles, and appliances, according to a story in the March issue of the *IEEE Institute*. This method uses many hours of recordings by real people saying real things and then labels and stores each voice bite by sound, melody or stressed syllables in a database. Someday printed instructions for VCRs will be obsolete because the machine will tell you how to program it, according to Schroeter.
- A new technology may pack the wallop of a home theater system into a pair of headphones, according to a story in the March 4 issue of *The New York Times*. The new technology, called Dolby headphones, makes use of head-related transfer functions (see *ECHOES* Spring 1998) to create the sense that sounds are passing around the room when they are actually coming from two small speakers. The brain senses that sounds are emanating from a particular place in space because of their timing and the number of overtones that reach each ear. The technology was developed by Lake Technologies, an Australian company from which Dolby licensed the system. To improve the surround effect, the company included reverberation data from an actual theater in the signal processor.
- Active feedback that creates "antisound" can reduce the ambient noise inside an automobile by as much as 6 dB, according to a note in the 6 February issue of *Nature* online. A system developed at the Korean Advanced Institute of Science and Technology (KAIST) uses vibration sensors to detect the noise and loudspeakers to counteract it. Highly variable road noises created by vibrations in the wheels that are transmitted through the suspension are particularly difficult to eliminate since they depend on speed, road surface, and suspension, among other factors. Thus there is no single ideal location for the vibration sensors, but a good compromise is to attach four sensors to the left and right front suspension.
- The latest ultrasound equipment takes realtime, moving, three-dimensional color pictures of a baby in the womb, according to a story in the April 11 issue of the *New York Times*. Only a few years ago the best ultrasound images were two-dimensional, grainy and black-and-white. The improvements are largely a result of improvements in computer capabilities. Since the 1970s, ultrasound machines that emit almost continuously have made it possible to record 12 to 40 frames per second, creating moving images that allow doctors to observe a beating heart, for example. Doppler mode ultrasound, which is used to observe blood flow, has been available since the 1980s.

ACOUSTICAL•SOCIETY•OF•AMERICA
SUITE 1NO1
2 HUNTINGTON QUADRANGLE
MELVILLE, NEW YORK 11747-4502

Non-Profit Org.
U.S. Postage
PAID
Hicksville, NY
Permit No. 289